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Yard Management System for Efficient Trailer Dispatches

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Abstract: ***This paper talks about digitalization of trailer dispatch process at coil yard of an integrated iron and steel plant. The system enables users to prepare trailer loading plans and helps monitor the progress in real-time. The application has built in interface with SAP system to automate the generation of dispatch related documents. It offers visibility to all the agencies engaged in trailer dispatch activities to enable efficient movement of trailers in and out of yards. It helps boost efficiency by automating delivery and invoice documents creation.***
Keywords: Sequence diagram, SAP, STO, Web service.

I. INTRODUCTION

In a year over 75000 trailer trips are made for transporting coils from yards to various outbound customer locations. Hot Strip Mill (HSM) has three coil yards ***viz***. C1, C2 and C3. Each yard has loading positions shown in **Figure 1,** where trailers are required to reach for loading the coils. According to the capacity of trailer and weight of coil a trailer is loaded with 1, 2 or more coils. In rare cases, coils to be loaded are distributed in two yards and accordingly a trailer must move to next yard for loading remaining coil(s).

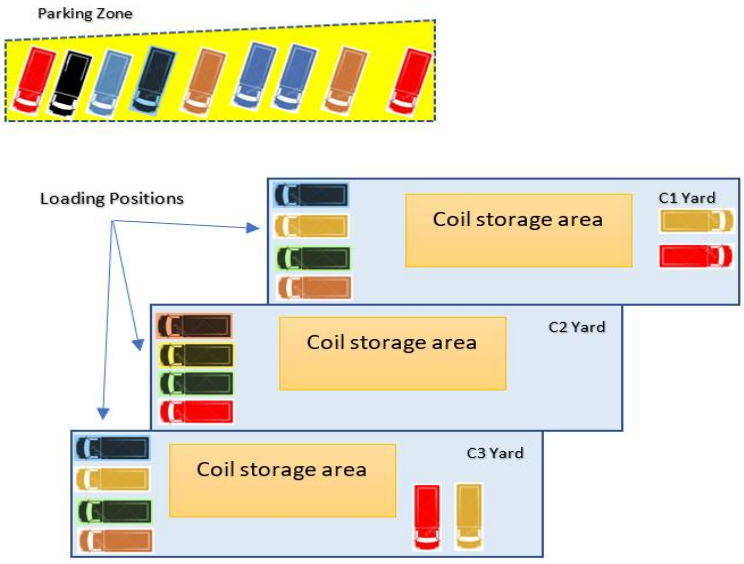

Figure 1: HSM yard layout showing trailer loading positions.

Trailer operators are not aware of the yard from which the coil(s) would be loaded and the loading sequence. If coils to be loaded are in two yards, the trailer operator does not know beforehand which yard to enter first and availability of loading point there. A trailer reaching the yard entrance out of its turn or without prior information on the availability of loading position holds the risk of introducing bottlenecks in the dispatch process [1]. To control the movement of trailers in the yard, a digitalized Yard Management System (YMS) needs to be developed to automate the dispatch related activities from planning till invoice generation. All the necessary information regarding the loading sequence and occupancy status of loading points to be made available to trailer operators at a central trailer registration window in digital format. The trailers will leave the parking zone and proceed towards its loading position only when its status becomes “free”.

Currently there is a lot of manual interventions at each stage of dispatch activities, most of the manpower is involved in preparation and record keeping of documents [2]. This results in high cycle time in information flow, no provision for real time tracking of dispatches, high use of paper and inaccuracies in information flow. YMS can simplify planning, loading and help tracking of all dispatch activities to reduce cycle time, faster and error free customer service, improvement in Vehicle-In Vehicle-out (VIVO) time of trailers and improvement in productivity. To automate dispatch documentation YMS will have data interface with existing SAP system. Transporter supervisors are not aware of the capacities of trailers before deployment. Frequently trailers get overloaded at HSM, which leads to held up of trailers after loading. The overloaded trailers are then unloaded and reloaded with coil(s) according to the allowed capacity of the trailers. YMS will also have data interface with existing RFID based Vehicle Tracking System (VTS) to capture capacity of trailers and implement adequate controls to ensure load planning of trailers is within allowed tolerance limits. It will improve safety by loading of trailers withing their carrying capacity, reduce cost of trailer re-unitization, improve efficiency by preventing unloading and re-loading of trailers. See **Figure-2** for proposed data interface between YMS and existing VTS and SAP systems. Moreover, due to COVID-19 pandemic there is an urgent need to enhance operational capabilities by promoting social distancing. YMS will improve safety by reducing the requirement of manpower movement in yards and boost their morale due to reduced workload.

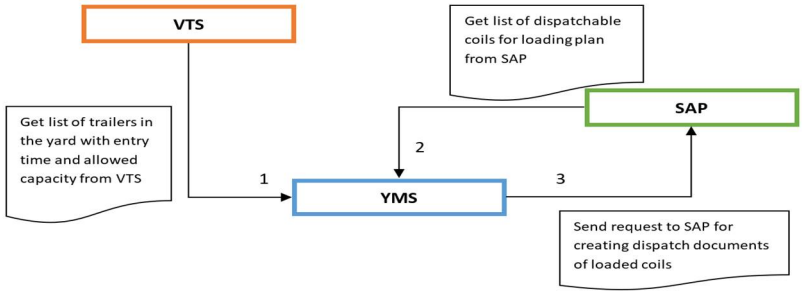

Figure 2: Proposed data interface of YMS with existing VTS and SAP systems for automation of load planning and dispatch documentation.

II. IMPLEMENTATION

A. FIFO Trailer Loading Plan

To ensure optimum movement of trucks from parking zone to the loading yard, a First-In-First-Out (FIFO) based logic is developed. In this method the trailer check-in timestamp is captured from VTS and displayed in the YMS planning web page. The planning in-charge can prepare the loading plan for trailers strictly on first come first serve basis and registers the plan in YMS. The FIFO system allows sequential and smooth movement of trailers in and out of the coil yard area. The coils to be loaded on a particular trailer are fetched from the SAP system according to the Stock Transport Order (STO). The in-charge then selects the loading point where the trailer will be loaded and confirms the plan. Unified Modelling Language (UML) [3] sequence diagram in **Figure-3** depicts the planning process implemented in YMS.

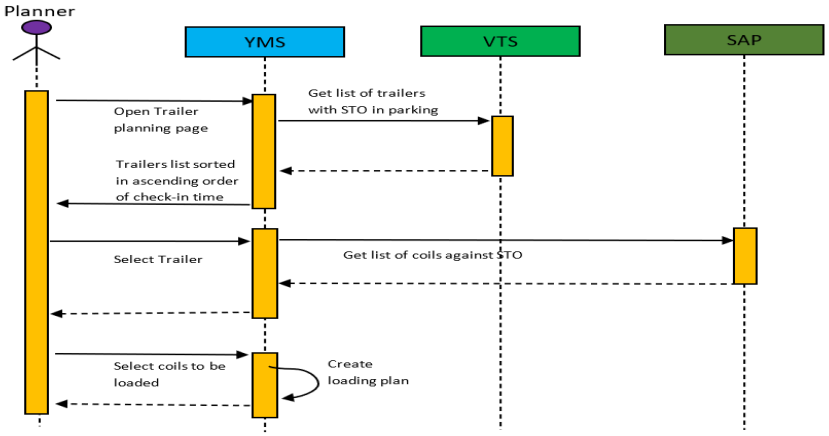

Figure 3: Sequence Diagram of trailer planning process showing interaction of YMS with VTS and SAP systems.

B. Automated Dispatch Documentation

After the loading plan of a trailer is confirmed the system then prepares loading sequence or priority of the trailer. The system ensures that loading priorities of trailers are assigned to support FIFO. The loading priority of planned trailers is flashed on the display board installed at the parking zone. Trailers having loading priority number of ***one*** can proceed from parking area to the loading position of the respective yard. The process of loading the coils starts after the trailer is parked at the loading position. According to the plan YMS sends a work order to the crane for retrieving coil from the yard and laying it down on the trailer. The process is repeated for loading subsequent coil(s) in the plan. After the coils are loaded and lashed to the trailer, loading in-charge inspects the coils and scans the barcode label pasted on the coil using a handheld scanning device. The barcode scanner sends the information of the loaded coils to the YMS web service through Wi-Fi network. The web service then forwards the required details to SAP system for delivery creation and invoice generation as shown in **Figure 4**.

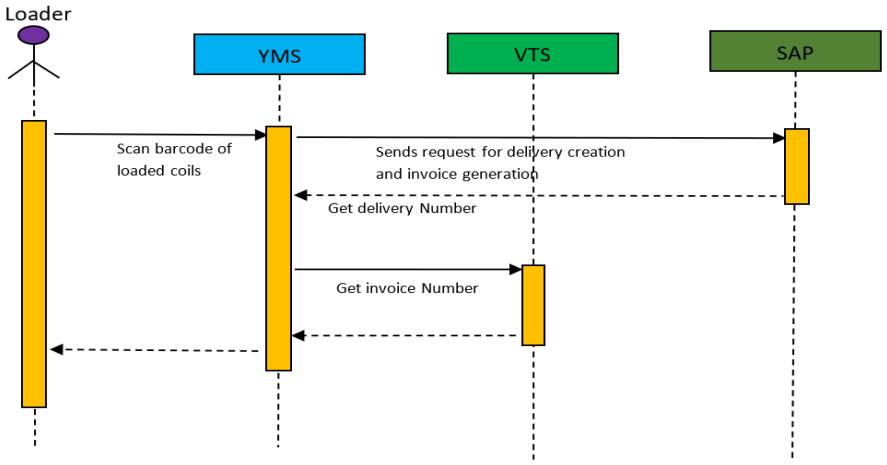

Figure 4: Sequence Diagram showing interaction of YMS with VTS and SAP systems for automated documents generation.

Trailers pass through *checked-in, registered, assigned,* and *evacuated* states while in the yard area. When a trailer enters parking area its status is shown as "checked-in". After the loading plan is created the trailer status is changed to "registered". When it reaches its loading position the loading in-charge changes its status to "assigned", and finally when the loaded coils are scanned the status is changed to "evacuated". After a trailer is evacuated the loading position becomes vacant and system automatically increments the loading priority of queued up registered trailers by one. Trailer with the loading priority "one" can now proceeds to the vacant loading position assigned by loading in-charge. Once assigned the system sends work order to crane to retrieve the planned coils from the storage area and load them on the trailer. **Figure 5** shows change in status of registered trailers planned to be loaded at loading position 1TRE11.

Trailer	Status	Loading Position	Loading Priority	Remarks
NL07A	ASSIGNED	1TRE11		Loading in progress
NL01K9	REGISTERED		1	Waiting to be assigned
NL02Q69	REGISTERED		2	
NL01L5	REGISTERED		3	

Trailer	Status	Loading Position	Loading Priority	Remarks
NL07A	EVACUATED			Loading completed
NL01K9	ASSIGNED	1TRE11		Loading in progress
NL02Q69	REGISTERED		1	Priority incremented. Waiting to be assigned
NL01L5	REGISTERED		2	Priority incremented

Figure 5: YMS automatically increments loading priorities of registered trailers.

C. Hardware and Software

1) *Backend:* Microsoft Visual Studio IDE was used for development of web services hosted on IIS. Data related to trailer loading stored in Oracle 19c database tables, see Table 1.
2) *Frontend:* Microsoft Visual Studio IDE was used for development of HTML web pages for visualizing the real-time status of trailers and hosted on IIS web server, see screenshots Figure 6 to Figure 9.

Table 1: Available hardware and software environment

Server Specifications	CPU: Intel Gold 5217, RAM: 64GB
Operating System	Windows 2019 Server
Development Environment	MS Visual Studio 2010
Programming Language	C# .Net, HTML, JavaScript
Web Server	IIS 10
Database	Oracle 19c
Client Desktop Computer	Windows 10, Internet Explorer, Chrome Browser

D. Screenshots

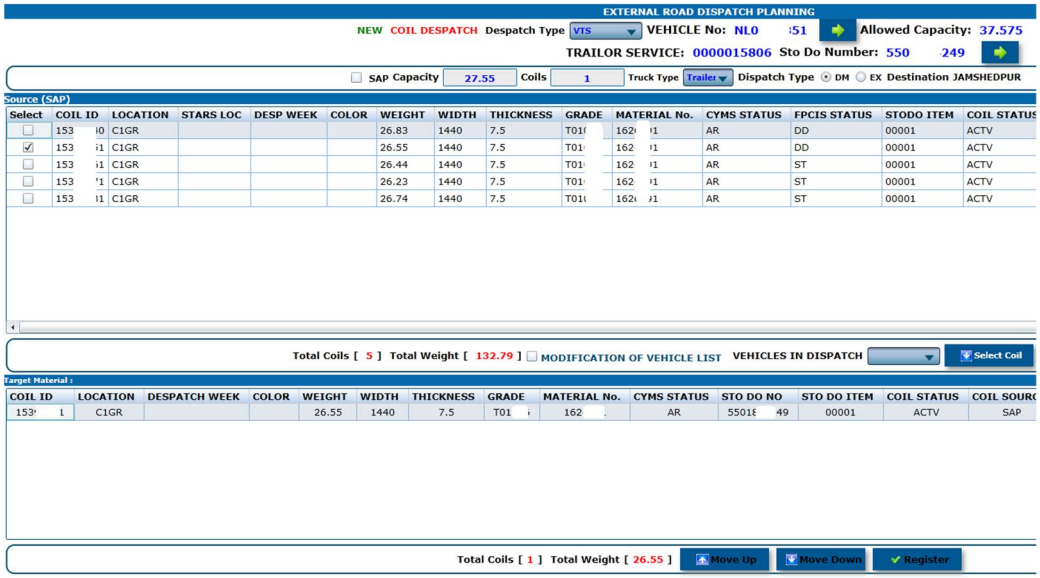

Figure 6: Trailer planning page for trailer registration.

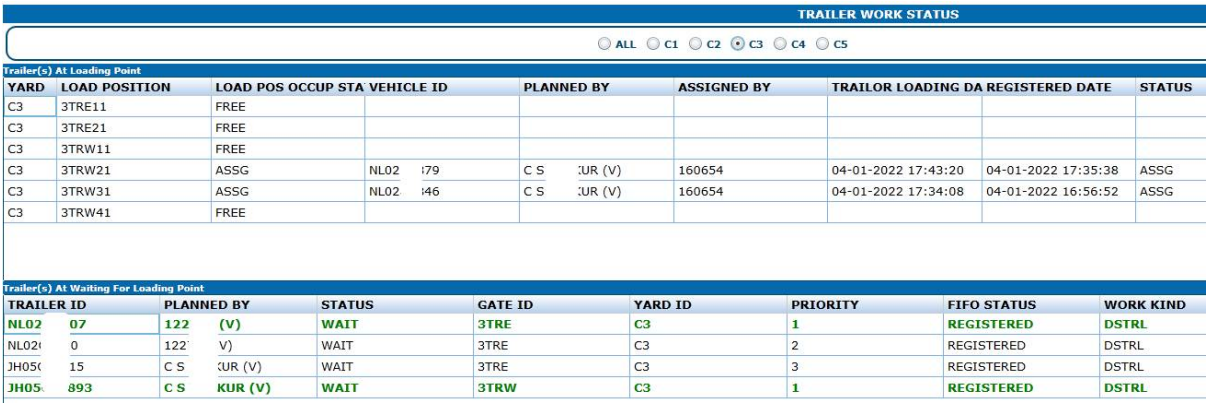

Figure 7: Loading position assignment page for registered trailers.

Delivery Status Details

TIME STAMP	TRUCK NO	DELIVERY NO	DESPACTH TYPE	STO DO NO	STO DO ITEM NO	COIL ID	SCAN STATUS	NO OF PIECES	QUANTITY
2022-01-04-18.01.45.884542	NL02(3	0901(95	DM	55018 53	00001	186 1	Y	1	23.94
2022-01-04-18.00.45.884532	JH05E 38	0901(93	DM	55018 95	00001	185 1	Y	1	23.97
2022-01-04-17.43.44.884492	NL01/ 19	0901(79	DM	55018 75	00001	185 0	Y	1	22.59
2022-01-04-17.43.44.884492	NL01/ 95	0901 74	DM	55018 97	00001	186 2	Y	1	25.43
2022-01-04-17.37.43.884472	JH05(9	0901 28	DM	55018 53	00001	185 1	Y	1	23.53
2022-01-04-17.23.42.884432	NL02(4	0901 98	DM	55018 75	00001	176 1	Y	1	27.2
2022-01-04-17.15.41.884413	NL01/ 59	0901 17	DM	55018 59	00002	174 1	Y	1	18.93
2022-01-04-17.15.41.884412	NL01/ 59	0901 17	DM	55018 59	00001	158 0	Y	1	22
2022-01-04-17.13.41.884402	NL02(0	0901 15	DM	55018 77	00001	176 1	Y	1	27.17
2022-01-04-17.08.40.884392	NL02(9	0901 79	DM	55018 18	00001	185 0	Y	1	24.04
2022-01-04-16.56.39.884362	NL02(4	0901 53	DM	55018 79	00001	175 1	Y	1	24.11
2022-01-04-16.23.36.884272	JH05/ 09	0901 26	DM	55018 47	00001	186 1	Y	1	24.77
2022-01-04-16.02.34.884222	NL02(4	0901 22	DM	55018 35	00001	170 2	Y	1	24.11
2022-01-04-16.01.34.884222	JH05E 81	0901(21	DM	95158 57	00001	178 9	Y	1	13.3
2022-01-04-16.00.34.884212	JH05C 72	0901(17	DM	55018 47	00001	185 30	Y	1	18.45

Figure 8: Delivery status page showing delivery and invoice details in SAP.

HOT STRIP MILL
COIL YARD MANAGMENT SYSTEM
DAILY DESPATCH REPORT

1/4/2022

Arrival 04-01-2022 09:06:23 **Vehicle** NL0 93 **Despatch** 04-01-2022 10:12:56 Yard **C1**
Delivery No. Transporter Name **ENTERPRISES**
1831 1 24.43 8
No. Of Coils 1 **Weight:** 24.43

Arrival 04-01-2022 09:10:42 **Vehicle** NL01A 9 **Despatch** 04-01-2022 10:34:25 Yard **C1**
Delivery No. Transporter Name **TRANSPORT PVT. LTD.**
1863 1 23.69 2
No. Of Coils 1 **Weight:** 23.69

Arrival 04-01-2022 09:12:51 **Vehicle** JH05C 5 **Despatch** 04-01-2022 11:05:46 Yard **C1**
Delivery No. Transporter Name **CARGO MOVERS**
1863(0 23.98 2
No. Of Coils 1 **Weight:** 23.98

CRM
Arrival 04-01-2022 05:34:31 **Vehicle** NL0 7 **Despatch** 04-01-2022 07:09:43 Yard **C2**
Delivery No. Transporter Name **TRANSPORT CO**
1830( ) 23.99 5.5
No. Of Coils 1 **Weight:** 23.99

Arrival 04-01-2022 06:56:58 **Vehicle** JH05B **Despatch** 04-01-2022 07:23:03 Yard **C3**
Delivery No. Transporter Name **Transport**
1855(23.79 2.5
No. Of Coils 1 **Weight:** 23.79

Figure 9: Dispatch report generated by the system.

III. CONCLUSION

Yard Management System addresses the inefficiencies during loading and dispatch documentation stages. It brings uniformity in yard management operations by systemically introducing controls during the load planning phase. It addresses safety concerns and unnecessary delays by regulating movements of trailers in and out of the yard by providing real-time information to the operators. It boosts productivity by eliminating manual document creation which is tedious and prone to mistakes. Further studies need to be conducted to measure the impact of the system in improving overall turnaround time of trailers.

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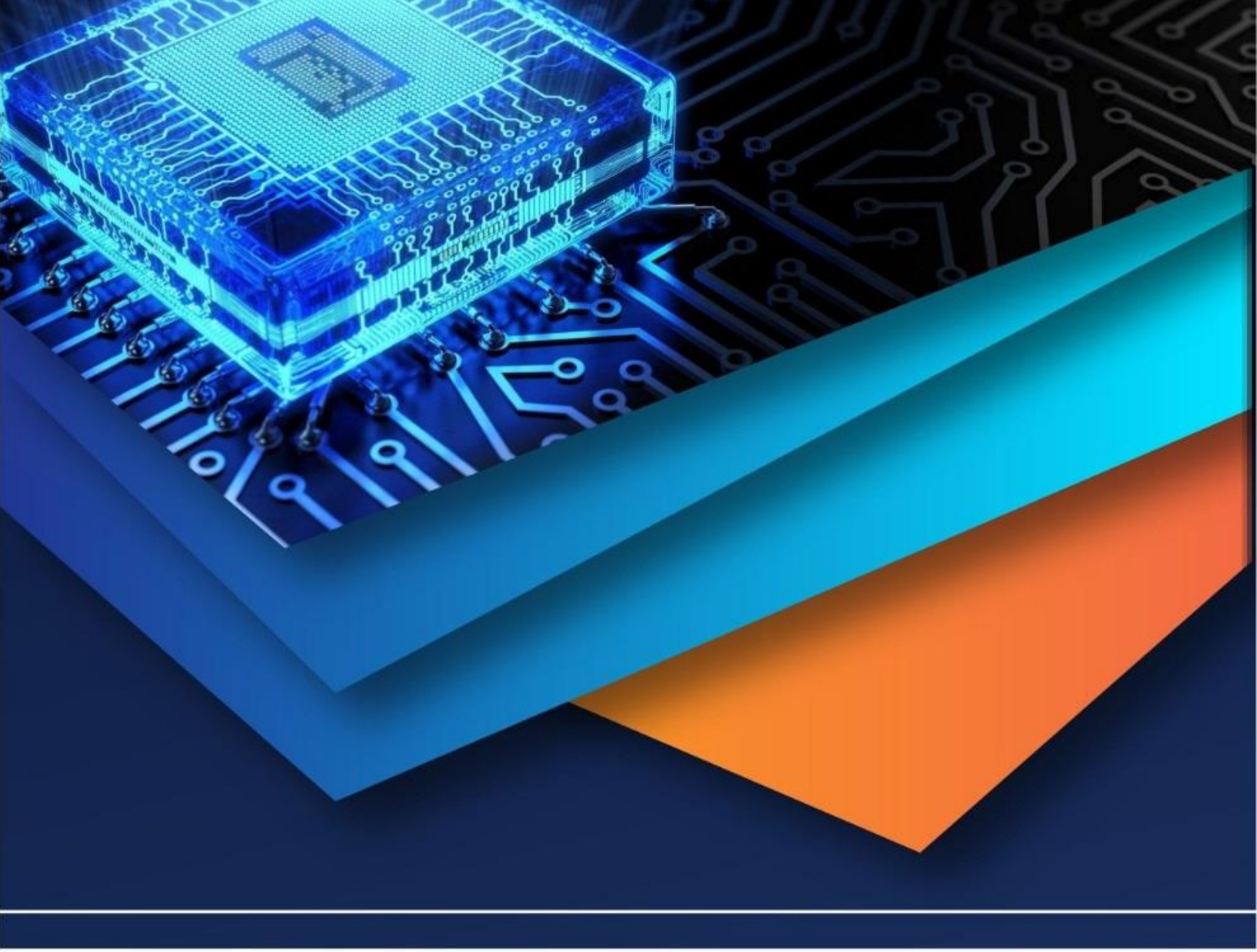
[3] R. Miles and K. Hamilton, Learning UML 2.0, 1st Edition, O'Reilly Media, 2006.



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